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# Karst Landforms in the Gypsum Lake Area; Character and Distribution

By W.D. M$^{c}$Ritchie and P. Voitovici
Winnipeg, 1990

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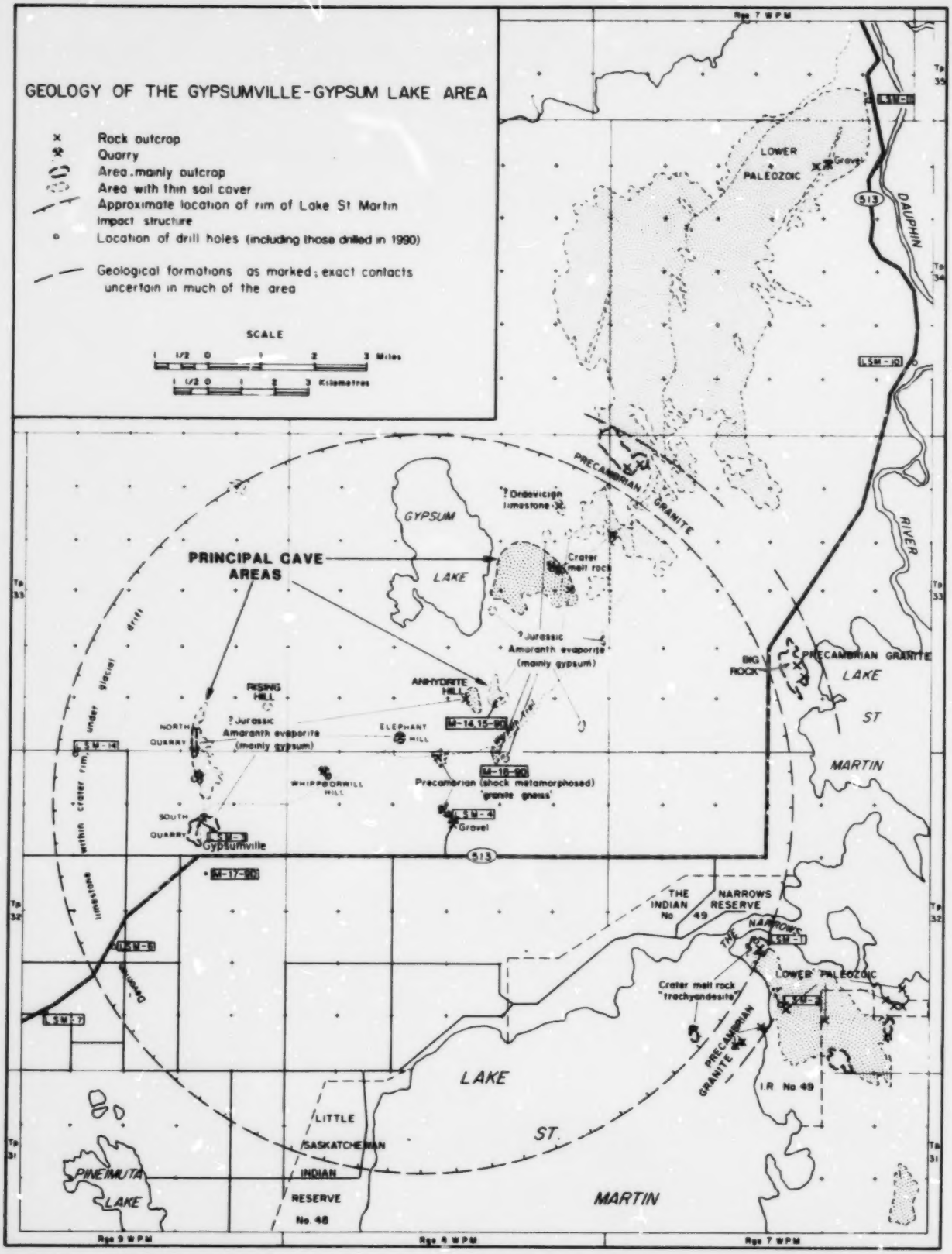


*Figure GS-29-1: Principal areas containing caves, Gypsumville region (Geology modified after McCabe and Bannatyne, 1970).*

# GS-29 KARST LANDFORMS IN THE GYPSUM LAKE AREA; CHARACTER AND DISTRIBUTION

by W.D. McRitchie and P. Voitovici[1]

McRitchie, W.D. and Voitovici, P. 1990: Karst landforms in the Gypsum Lake area; character and distribution; in Manitoba Energy and Mines, Minerals Division, Report of Activities, 1990, p. 128-139.

During 1990 Karst studies in Manitoba's Interlake region concentrated mainly on the task of documenting the distribution and character of bedrock solution features near Gypsumville and Gypsum Lake. Numerous new discoveries, made late in 1989, of caves, shafts and cockpit karst east and south of Gypsum Lake, provided an even sharper focus for much of the summer's investigations. An initial inventory of these features is presented in this report.

Elsewhere in the Interlake, several reconnaissance traverses were conducted in the Grand Rapids region, and in the country between Ashern, Mantagao, and St George Lakes, where recent forest fires (1989) have revealed extensive new areas of bedrock exposure.

## GYPSUMVILLE/GYPSUM LAKE

An introductory description of the karst landforms in the Gypsumville and Gypsum Lake area was presented by Voitovici and McRitchie (1989). Earlier references to the caves in the region are found in reports by J.B. Tyrrell (1888), D.B. Dowling (1902), E.M. Kindle (1913), L.H. Cole (1913), G.M. Broenell (1931), and M. Hoque (1967). Tyrrell's comments were restricted to the area north of Gypsumville itself, with active quarrying by the Manitoba Union Mining Company beginning in 1901. By 1912, the region appears to have been more extensively explored, most gypsum occurrences (including those east and south of Gypsum Lake) had been staked, and presumably the existence of caves throughout the region was known. Kindle (1913) noted, "The surface of the gypsum deposits is deeply pitted with sink holes which carry much of the drainage into subterranean channels", and these features were routinely used by the early explorers to denote areas underlain by gypsum bedrock. Hoque's (1967) study of the folding and linear structures in the region provides the first quantitative information on sinkhole distribution including a detailed map depicting the distribution of sinks in the immediate area of the quarries north of Gypsumville. No further studies appear to have been made in the twenty year period following, until the caves were rediscovered by members of the Speleological Society of Manitoba (SSM).

[1]Speleological Society of Manitoba

## REGIONAL INVENTORY

With the knowledge that gypsum occurrences and karst features were widespread in the Gypsumville area (Fig. GS-29-1), a plan was developed to mount a systematic inventory that would build on the discoveries made in 1989. Ground traverses were laid out to cover the entire region east and south of Gypsum Lake, together with a helicopter reconnaissance of the broader region. In late May, eleven east/west flight lines, spaced one mile apart, were flown between Gypsumville and Big Rock (Fig. GS-29-1), with Highway 513 as the southern boundary of the study area.

All bedrock occurrences were noted, and several photographs taken of representative topographic and karst landforms (Fig. GS- 29-2, -3, -4, -5). Thick and continuous tree cover thwarted attempts to develop a quantitative classification of the karst morphologies during the limited duration of the aerial survey. Areas underlain by gypsum bedrock are limited in large part to those defined on Wallace's 1914 map (Fig. GS-29-6), the region to the north being covered by extensive boulder till, moraine, and other recent deposits.

A subsequent attempt was made to obtain systematic aerial coverage of the karst landforms using a video camera from a Piper Supercub, but this also proved unsuccessful. Consequently it was concluded that systematic ground traverses would be the best approach to continue comprehensive documentation of the karst landforms, and much of the summer was spent in this endeavour (Fig. GS-29-7).

Results have been compiled into a provisional terrain morphology classification for the regions east and south of Gypsum Lake, based on topographic relief, sinkhole density, depth, diameter and shape (Fig. GS-29-8, GS-29-9). A second order classification describing the relative frequency of cave openings is also presented in these figures that attempt, for the first time, to rank the relative importance of karst landforms.

Topographic relief in the northern sector is locally extreme with ridges 10 to 15 m above the base of the larger sinks. This is the main region of polygonal karst, and future studies should be undertaken to complete a systematic morphometric analysis of the dolines. The importance of suffosion in developing many of the landforms was suggested by D. Ford during a visit to the area, and the restricted "clustered" distribution of many of the caves near the edge of topographic highs (and

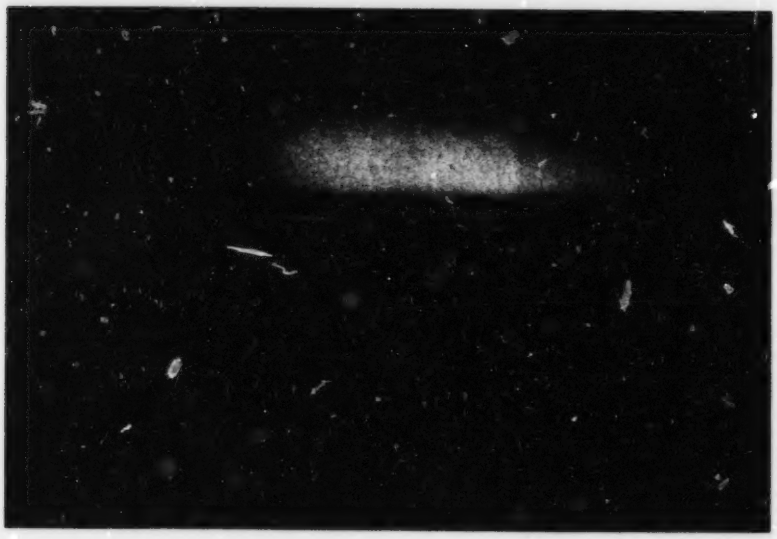

*Figure GS-29-2: Iceberg scours in the region south of Gypsum Lake.*

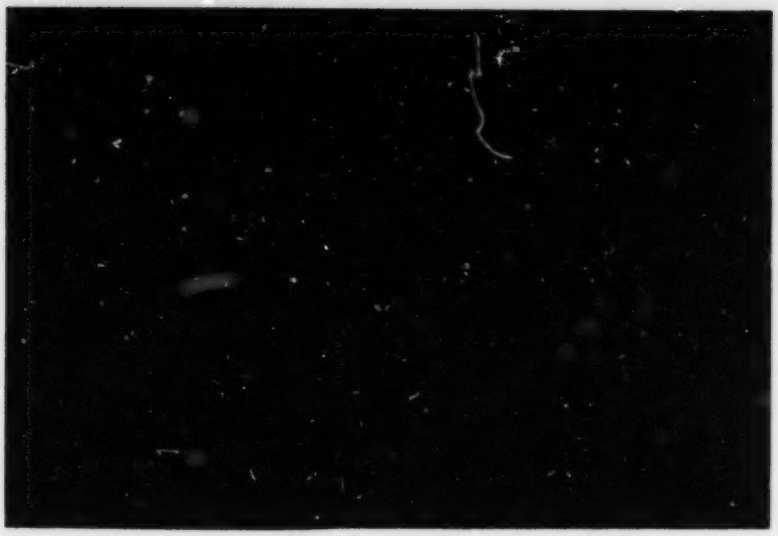

*Figure GS-29-3: Sinkhole infested terrain, south of Gypsum Lake.*

*Figure GS-29-4: Typical sinkholes west of "Hook" Sleugh.*

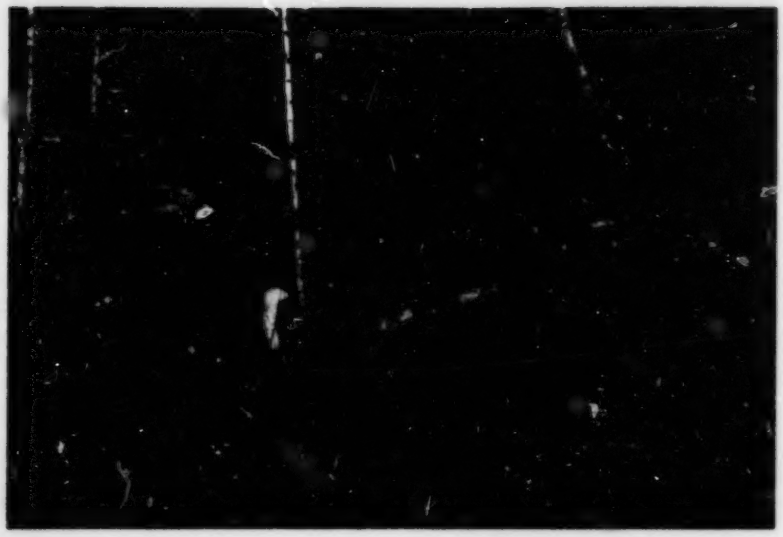

*Figure GS-29-5: 5 m high escarpment of folded gypsum near Fold Cavern, northern sector, Gypsum Lake, east.*

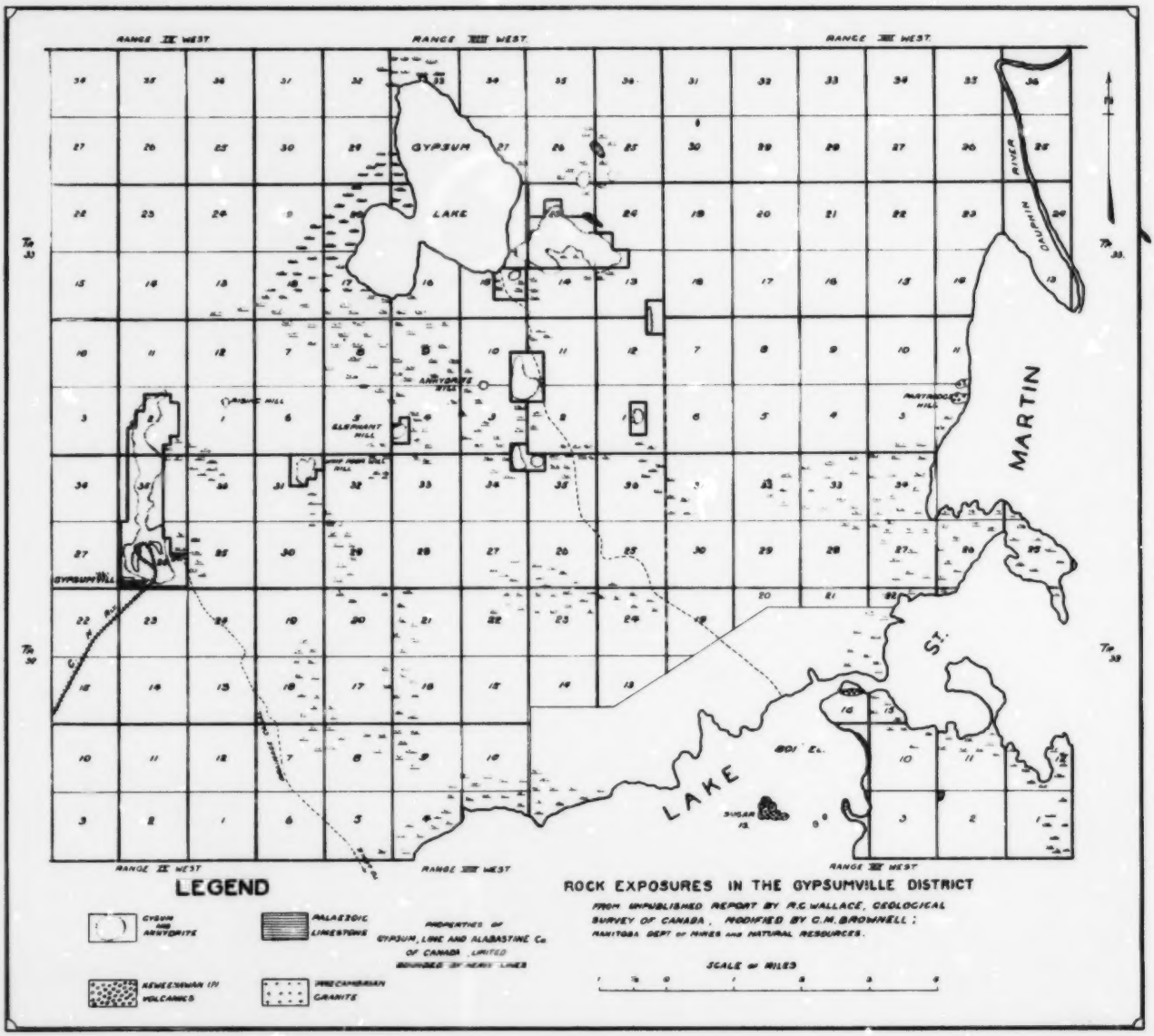


*Figure GS-29-6: Rock exposures in the Gypsumville district (from unpublished report by R.C.Wallace (1914), modified by G.M. Brownell (1931).*

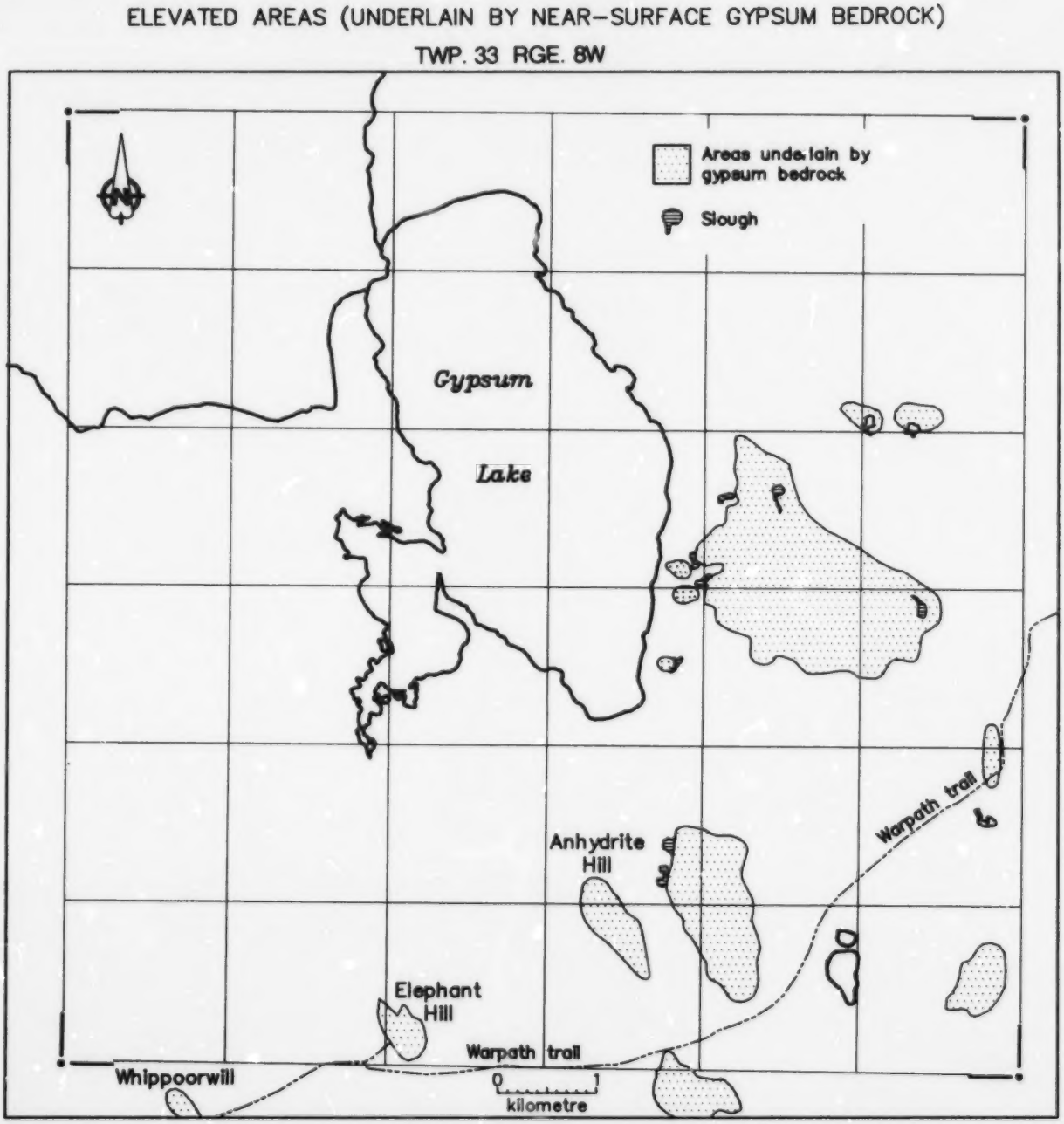


*Figure GS-29-7: Gypsum Lake; elevated areas potentially underlain by near-surface gypsum bedrock (including associated red beds).*

## GYPSUM LAKE: PROVISIONAL TERRAIN MORPHOLOGY CLASSIFICATION (Northern Sector)

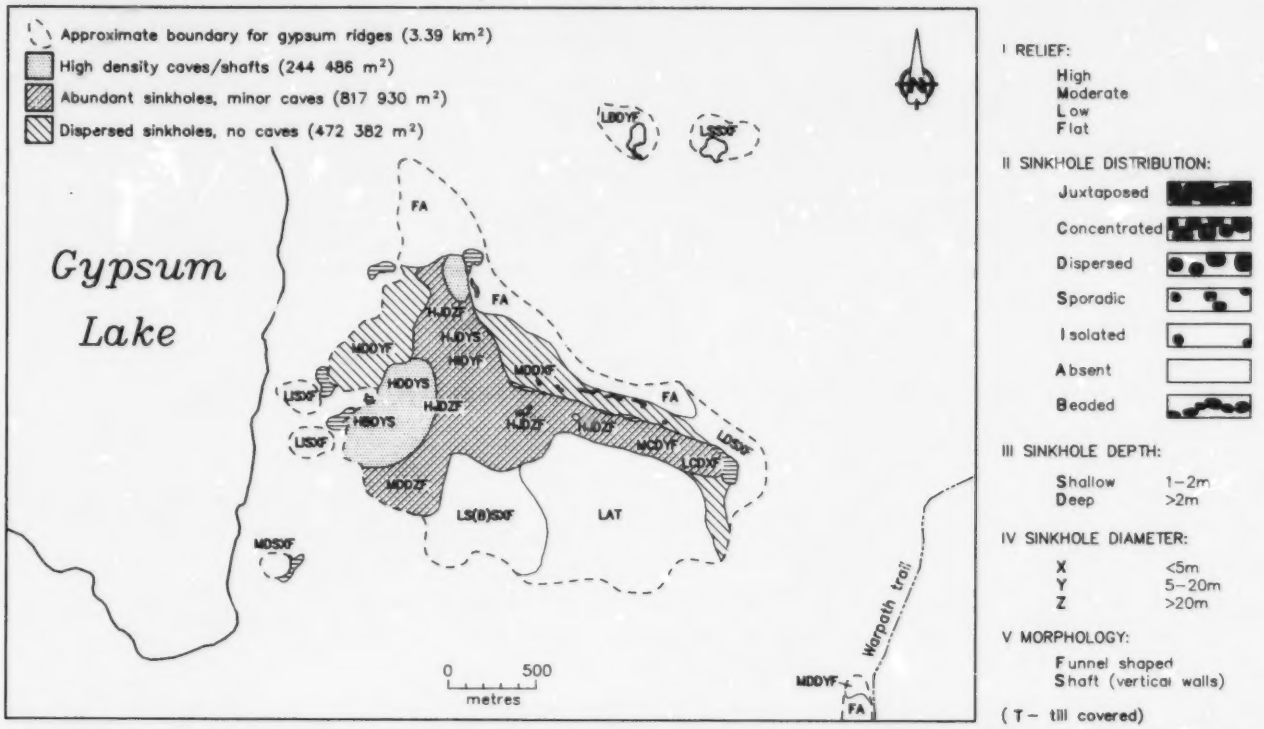


*Figure GS-29-8: Gypsum Lake; provisional terrain morphology classification (northern sector). Note; **FISXF translates as Flat (relief), Isolated (sinkhole distribution), Shallow (sinkhole depth), 5 m (sinkhole diameter), Funnel- shaped (morphology).***

## GYPSUM LAKE: PROVISIONAL TERRAIN MORPHOLOGY CLASSIFICATION (Southern Sector)

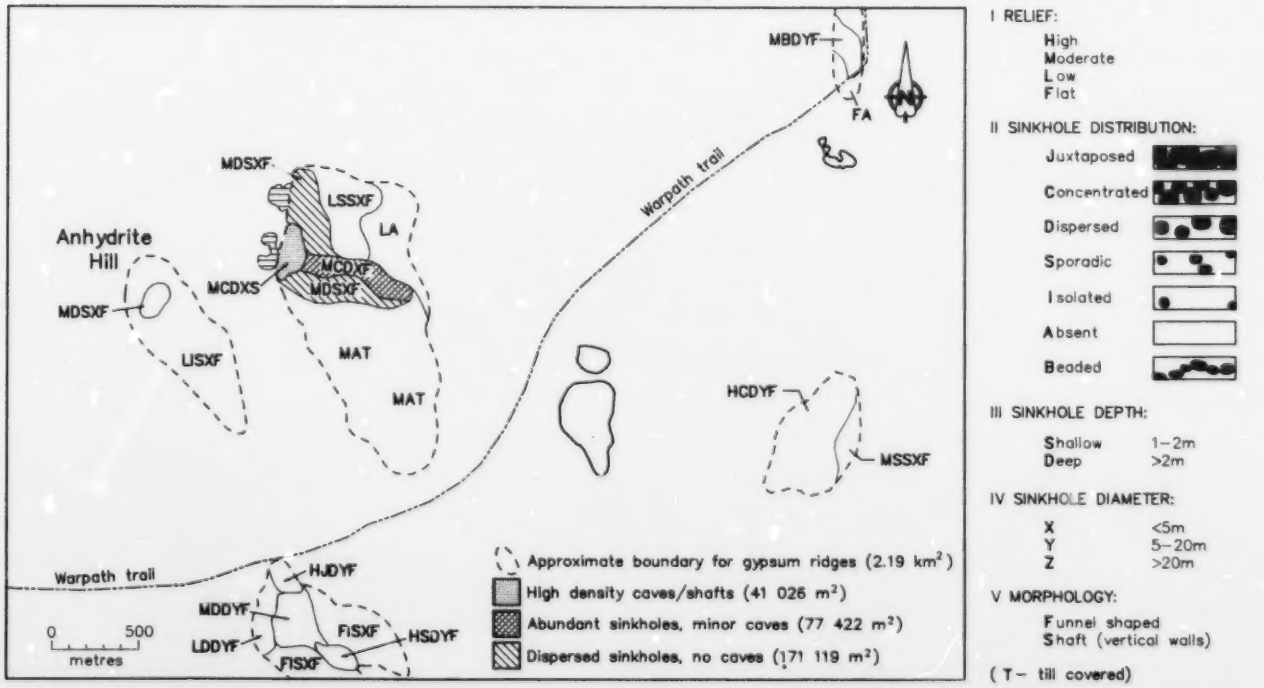


*Figure GS-29-9: Gypsum Lake: provisional terrain morphology classification (southern sector). Note; **HJDYF translates as High (relief), Juxtaposed (sinkhole distribution), Deep (sinkhole depth), 5-20 m (sinkhole diameter), Funnel- shaped (morphology).***

adjacent to beaver ponds), bears a strong resemblance to the progressive development of "Schlotten" topography in massive gypsum near Windsor, Nova Scotia (Ford and Williams, 1989, p. 459).

## CAVE EXPLORATION

Numerous small cave entrances have been discovered east and south of Gypsum Lake (Fig. GS-29-10 , GS-29-11; Table GS-29-1). Several of the bigger caves were mapped in late 1989 (Fig. GS-29- 14), the largest being the **Catacomb-Satin Spar** complex (Fig. GS-29- 14a), which at 202 m, now represents the longest cave documented in Manitoba.

Traverses north and east of the Labyrinth Cluster and due east of the same feature came close to the eastern limit of the karst highlands, and uncovered numerous new cave entrances including **Fold Cavern** (Figs. GS-29-12, GS-29-13 and GS-29-14b), which possesses not only the largest chamber yet discovered in gypsum bedrock of this region, but also rooms with the greatest depth below the surface (8 m). Striking two metre relief folds are the cave's most noticeable feature (Fig. GS-29-13). Although these are typically chevron folds with sharp axial closures, more gentle open structures also exist and it is these that appear to provide the arches that support the ceiling of the cavern's main chamber. Enterolithic and nodular structures are also abundant in both anhydrite and gypsum beds. Salt solution fretworks observed in a nearby escarpment (Fig. GS-29-5) possibly denote the prior occurrence of halite in the evaporite sequence.

Other caves discovered in the region tend to be low (50 cm) semicylindrical crawlways, 2 to 4 m below the surface that follow the principal joint directions (see **Wishbone**, Fig. GS-29-14c). Several display preferred solution with one stratigraphic unit yielding extensive low (39-50

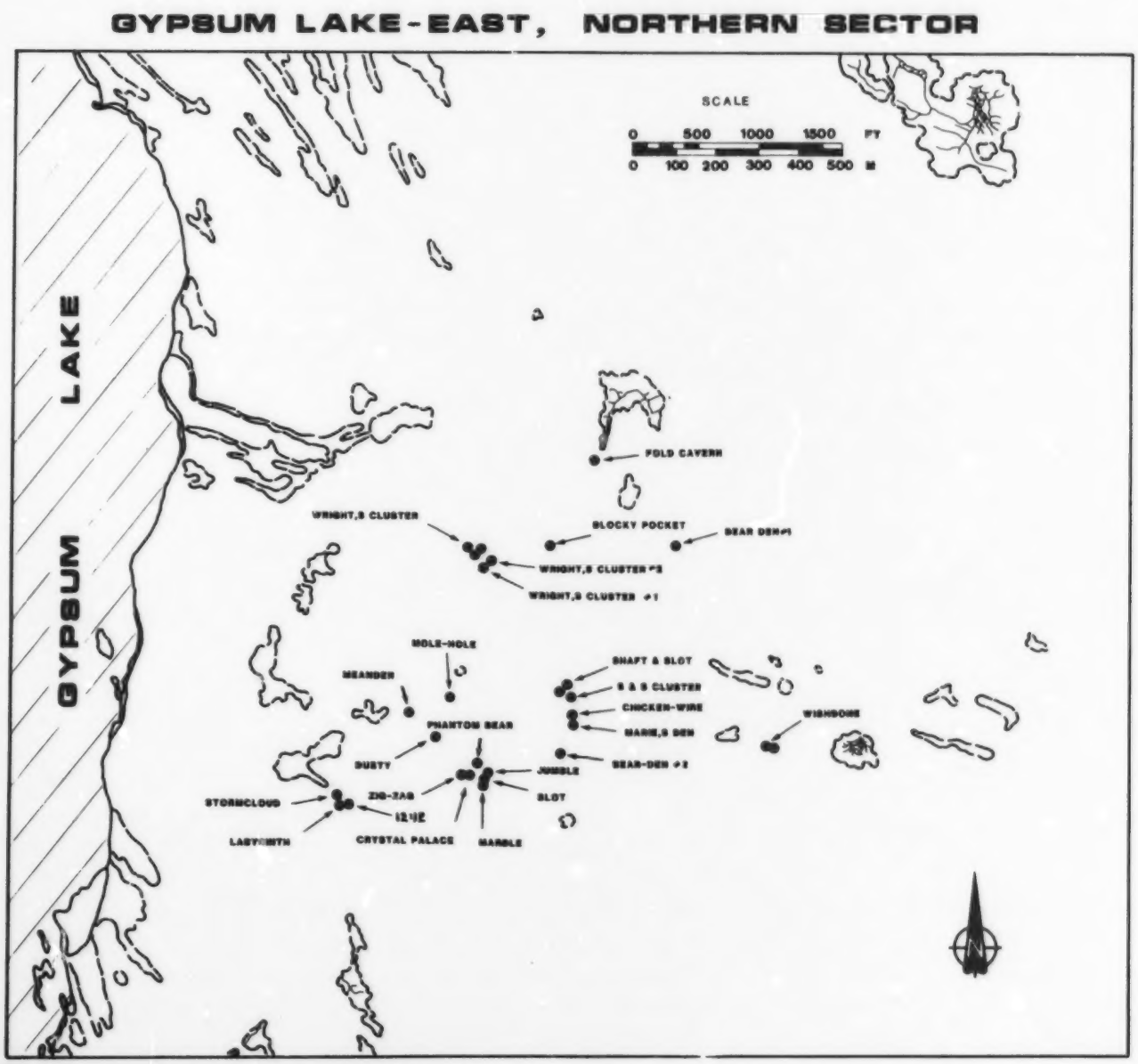


*Figure GS-29-10: Caves explored east of Gypsum Lake.*

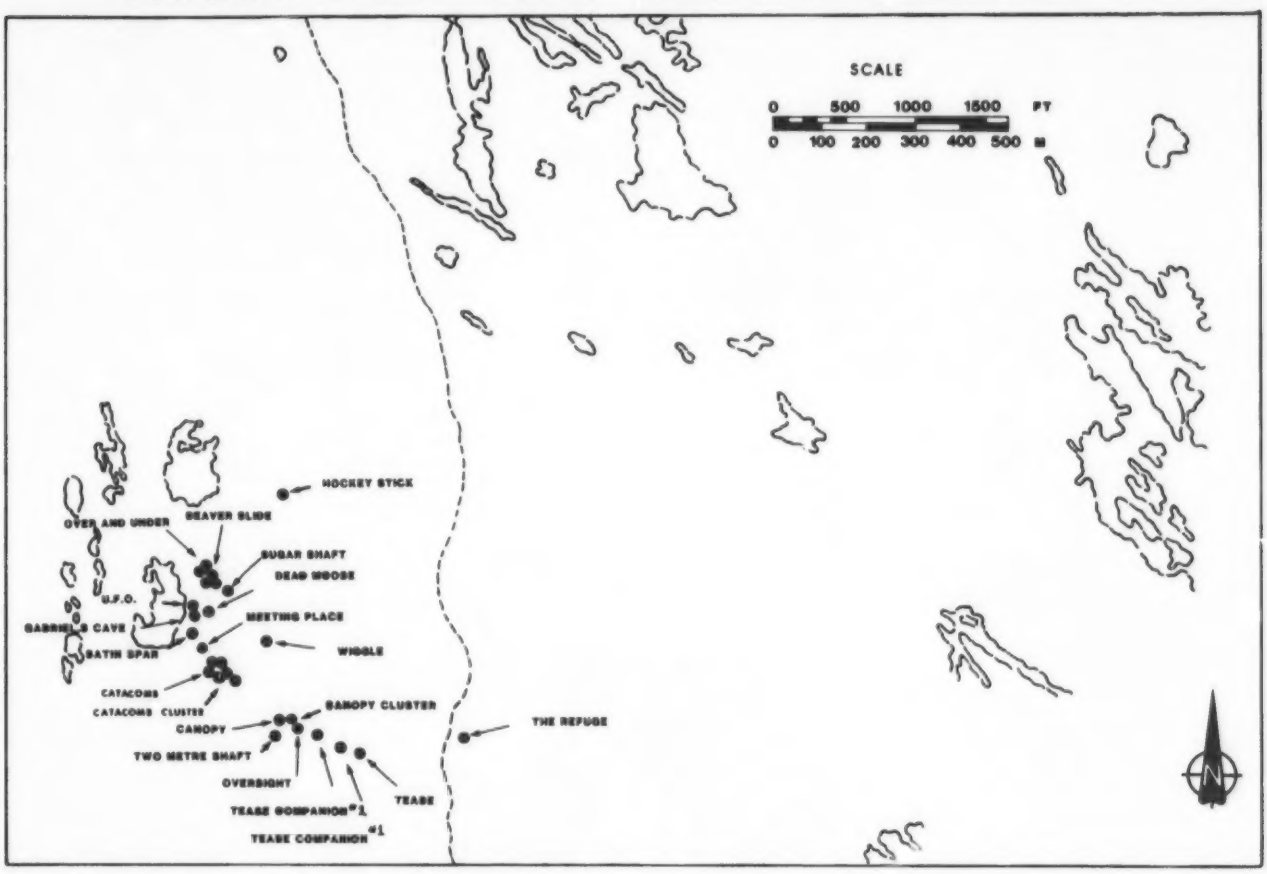


*Figure GS-29-11: Caves explored south of Gypsum Lake.*

**Table GS-29-1**
**Caves, Sinkholes and trenches in the Interlake region, status of investigations for discoveries made during 1989/90**

| | Cave Name | Unconfirmed Report | Located | Sketched | Mapped | L (Metres) | D |
|---|---|---|---|---|---|---|---|
| GRAND RAPIDS: | | | | | | | |
| GR1 | Ice Organ | .... | xxxx | .... | xxxx | 36.0 | 8.6 |
| GR2 | Mouldy-moth | .... | xxxx | .... | xxxx | 12.5 | 3.4 |
| GR3 | Chain | .... | xxxx | .... | .... | 3.5 | 2.0 |
| GR4 | Lookout Crevice | .... | xxxx | .... | .... | 43.0 | 5.0 |
| GR5 | Wet Memory | .... | xxxx | .... | .... | 2.0 | 1.0 |
| GR6 | Skull trench | .... | xxxx | .... | .... | 15.0 | 5.0 |
| GR7 | Cliff Cave | .... | xxxx | xxxx | .... | 10.0 | 7.0 |
| GR8 | Drop-in | .... | xxxx | xxxx | .... | 11.0 | 2.4 |
| GR9 | Wine Cellar | .... | xxxx | xxxx | .... | 27.0 | 9.4 |
| | | | | | Subtotal | 160.0 | |
| GYPSUMVILLE: | | | | | | | |
| GQ1 | Crystal Kingdom | .... | xxxx | .... | xxxx | 19.5 | 1.5 |
| GQ2 | Long Crawl | .... | xxxx | .... | xxxx | 125.5 | 3.0 |
| GQ3 | Octopus | .... | xxxx | .... | xxxx | 46.0 | 1.2 |
| GQ4 | Log Barricade | .... | xxxx | xxxx | .... | - | - |
| GQ5 | Short Crawl | .... | xxxx | .... | xxxx | 23.0 | 1.4 |
| GQ6 | Moth's Cellar | .... | xxxx | .... | xxxx | 23.5 | 2.0 |

**Table GS-29-1 (cont'd)**

| | Cave Name | Unconfirmed Report | Located | Sketched | Mapped | L (Metres) | D |
|---|---|---|---|---|---|---|---|
| GQ7 | Jaws | .... | xxxx | .... | xxxx | 16.0 | 1.5 |
| GQ8 | Snuggy Crawl | .... | xxxx | .... | xxxx | 19.0 | 1.5 |
| GQ9 | Honeypot | .... | xxxx | .... | xxxx | 37.0 | 1.8 |
| GQ10 | Bear's Den | .... | xxxx | .... | .... | 14.0 | 0.5 |
| GQ11 | Too-tight | .... | xxxx | .... | xxxx | - | - |
| GQ12 | Iceslide | .... | xxxx | .... | xxxx | 38.0 | 1.5 |
| GQ13 | Maze | .... | xxxx | .... | xxxx | 76.5 | 1.2 |
| GQ14 | Small Maze | .... | xxxx | .... | xxxx | 31.0 | 1.0 |
| GQ15 | Vertebrae | .... | xxxx | .... | xxxx | 23.0 | 0.5 |
| GQ16 | Spike | .... | xxxx | .... | xxxx | 16.5 | 0.5 |
| GQ17 | "Y" | .... | xxxx | .... | xxxx | 33.0 | 1.4 |
| GQ18 | Chamber | .... | xxxx | .... | xxxx | 55.0 | 1.4 |
| GQ19 | Tunnel | .... | xxxx | .... | xxxx | 7.0 | 1.0 |
| GQ20 | Transverse | .... | xxxx | .... | xxxx | 14.0 | 0.5 |
| GQ21 | Steepsink | .... | xxxx | xxxx | .... | - | - |
| GQ22 | Cliff | .... | xxxx | xxxx | .... | - | - |
| GQ23 | Slab | .... | xxxx | .... | xxxx | 16.5 | 3.6 |
| GQ24 | Bear Den | .... | xxxx | .... | xxxx | 14.0 | 0.5 |
| GQ25 | Nine foot pole | .... | xxxx | .... | xxxx | 12.5 | 1.8 |
| | | | | | Subtotal | 660.5 | |
| GYPSUM LAKE EAST (NORTHERN SECTOR): | | | | | | | |
| GLN1 | Stormcloud | .... | xxxx | .... | .... | - | - |
| GLN2 | Phantom Bear | .... | xxxx | xxxx | .... | 39.5 | 5.5 |
| GLN3 | Labyrinth | .... | xxxx | .... | xxxx | 189.0 | 4.8 |
| GLN4 | Zig-zag | .... | xxxx | xxxx | .... | 24.5 | 2.6 |
| GLN5 | Meander | .... | xxxx | .... | xxxx | 73.5 | 5.5 |
| GLN6 | Crystal Palace | .... | xxxx | .... | xxxx | 92.6 | 3.4 |
| GLN7 | Dusty | .... | xxxx | .... | .... | 15.0 | 2.0 |
| GLN8 | Mole-Hole | .... | xxxx | .... | .... | - | - |
| GLN9 | Blocky Pocket | .... | xxxx | .... | .... | - | - |
| GLN10 | Fold Cavern | .... | xxxx | .... | xxxx | 62.5 | 7.5 |
| GLN11 | Bear Den #1 | .... | xxxx | .... | .... | - | - |
| GLN12 | Wright's Cluster (#1) | | xxxx | xxxx | .... | 8.0+ | 1.0 |
| GLN13 | Wright's Cluster (#2) | | xxxx | .... | xxxx | 16.0+ | 2.4 |
| GLN14 | Wright's Cluster (#3) | | xxxx | .... | .... | - | - |
| GLN15 | Wright's Cluster (#4) | | xxxx | .... | .... | - | - |
| GLN16 | Wright's Cluster (#5) | | xxxx | .... | .... | - | - |
| GLN17 | Jumble | .... | xxxx | .... | .... | - | - |
| GLN18 | Slot | .... | xxxx | .... | .... | - | - |
| GLN19 | Marble | .... | xxxx | .... | .... | - | - |
| GLN20 | Marie's Den | .... | xxxx | .... | .... | - | - |
| GLN21 | Bear-den #2 | .... | xxxx | .... | .... | - | - |
| GLN22 | Chicken-wire | .... | xxxx | .... | .... | - | - |
| GLN23 | Shaft & Slot | .... | xxxx | .... | .... | - | - |
| GLN24 | S & S Cluster #1 | .... | xxxx | .... | .... | - | - |
| GLN25 | S & S Cluster #2 | .... | xxxx | .... | .... | - | - |
| GLN26 | S & S Cluster #3 | .... | xxxx | .... | .... | - | - |
| GLN27 | S & S Cluster #4 | .... | xxxx | .... | .... | - | - |
| GLN28 | Wishbone | .... | xxxx | .... | xxxx | 22.0 | 3.0 |
| | | | | | Subtotal | 542.6 m | |
| GYPSUM LAKE EAST (SOUTHERN SECTOR): | | | | | | | |
| GLS1 | The Refuge | .... | xxxx | .... | .... | - | - |
| GLS2 | Tease | .... | xxxx | .... | xxxx | 10.5 | 2.2 |
| GLS3 | Tease Companion (#1) | | xxxx | .... | .... | - | - |
| GLS4 | Tease Companion (#2) | | xxxx | .... | .... | - | - |
| GLS5 | Oversight | .... | xxxx | .... | .... | - | - |
| GLS6 | Canopy | .... | xxxx | xxxx | xxxx | 38.0 | 1.5 |
| GLS7 | Canopy Cluster (#1) | | xxxx | .... | .... | - | - |
| GLS8 | Canopy Cluster (#2) | | xxxx | .... | .... | - | - |
| GLS9 | Two metre shaft | | xxxx | .... | .... | - | - |
| GLS10 | Catacomb | .... | xxxx | .... | xxxx | 201.0 | 2.7 |

**Table GS-29-1 (cont'd)**

| | Cave Name | Unconfirmed Report | Located | Sketched | Mapped | L (Metres) | D |
|---|---|---|---|---|---|---|---|
| GLS11 | Meeting Place | .... | xxxx | .... | xxxx | - | - |
| GLS12 | Satin Spar | .... | xxxx | .... | xxxx | - | - |
| GLS13 | Catacomb Cluster (#1) | | xxxx | .... | .... | - | - |
| GLS14 | Catacomb Cluster (#2) | | xxxx | .... | .... | - | - |
| GLS15 | Catacomb Cluster (#3) | | xxxx | .... | .... | - | - |
| GLS16 | Catacomb Cluster (#4) | | xxxx | .... | .... | - | - |
| GLS17 | Satin Spar Cluster (#1) | | xxxx | .... | .... | - | - |
| GLS18 | Satin Spar Cluster (#2) | | xxxx | .... | .... | - | - |
| GLS19 | Gabriel's Cave | .... | xxxx | .... | .... | - | - |
| GLS20 | U.F.O. | .... | xxxx | .... | .... | - | - |
| GLS21 | Beaver Slide | .... | xxxx | .... | .... | - | - |
| GLS22 | Over and Under | .... | xxxx | .... | .... | | |
| GLS23 | BS Cluster (#1) | .... | xxxx | .... | .... | - | - |
| GLS24 | BS Cluster (#2) | .... | xxxx | .... | .... | - | - |
| GLS25 | BS Cluster (#3) | .... | xxxx | .... | .... | - | - |
| GLS26 | BS Cluster (#4) | .... | xxxx | .... | .... | - | - |
| GLS27 | Sugar Shaft (3Entr) | .... | xxxx | xxxx | .... | - | - |
| GLS28 | Dead Moose | .... | xxxx | .... | .... | - | - |
| GLS29 | Wiggle | .... | xxxx | .... | .... | - | - |
| GLS30 | Hockey Stick | .... | xxxx | .... | .... | 30.0 | 3.0 |
| | | | | | Subtotal | 279.5 m | |
| FAIRFORD: | | | | | | | |
| Snakepit | | .... | xxxx | .... | xxxx | 18.3 | 4.8 |
| Cockpit | | .... | xxxx | .... | .... | 3.0 | 1.5 |
| Baillie's pit .... | | .... | .... | .... | - | - | |
| DALLAS: | | | | | | | |
| Doug's Den.... | | xxxx | .... | xxxx | 10.5 | 4.5 | |
| Clarence's Cave .... | | xxxx | .... | xxxx | 11.0 | 4.0 | |
| SPENCE LAKE: | | | | | | | |
| The Tomb .... | | xxxx | .... | xxxx | 13.5 | 1.8 | |
| | | | Passage length | | Overall Total | 1698.9 | |

Total number of cave entrances located during 1989, 100 plus 14 referrals not yet confirmed.

| | | |
|---|---|---|
| Cave entrances | Overall Total | 114 |

Others reported from Mafeking (1), Highrock (5), Peonan Point (2), Mantagao (3), Ashern Road east (2), Vidir (1) and St. George Rd. (3).

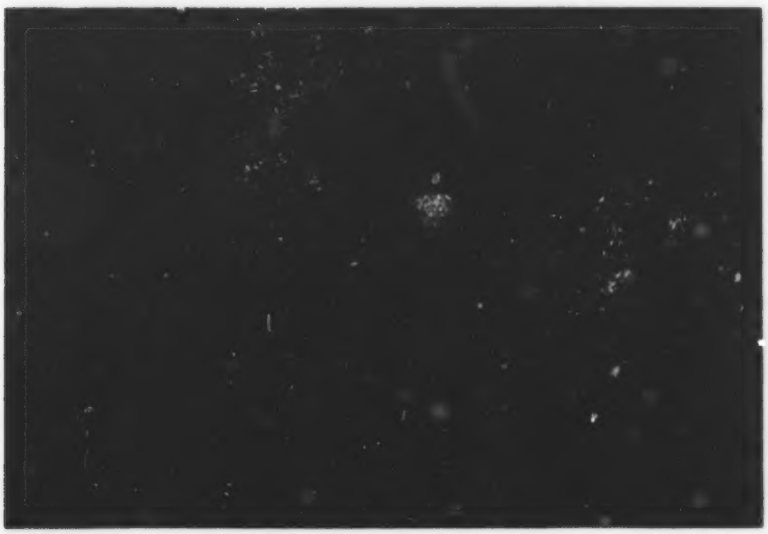

*Figure GS-29-12: Entrance to* ***Fold Cavern****, east of Gypsum Lake.*

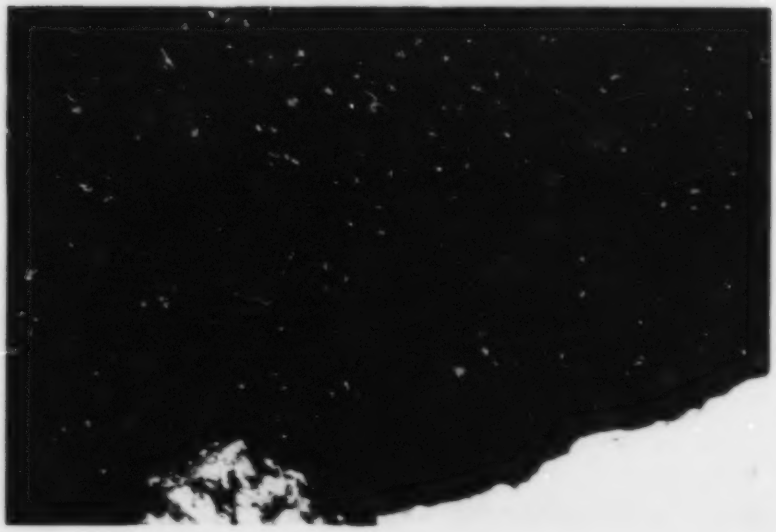

*Figure GS-29-13: Tightly folded gypsum beds in entrance chamber of* ***Fold Cavern****, east of Gypsum Lake.*

cm) chambers up to 15 m in diameter, similar in many respects to the main chambers of **Phantom Bear** and **Crystal Palace** Caves (Voitovici and McRitchie 1989).

Vertical solution-grooved shafts (2-3 m diameter and 3-4 m deep) are not uncommon, and two caves (**Marble** and **Chicken-Wire**) contain good exposures of chicken-wire texture with 5 to 12 cm gypsum nodules separated by thin buff to red stringers of dolomitic mud. Gypsum popcorn is widespread in the **Jumble** and **Slot** Cluster, and was also noted in several other caves.

Traverses south of Gypsum Lake (Fig. GS-29-11 southern sector) located an extensive array of solution-grooved shafts and sinks at the western limit of the upland area, bordering on two prominent beaver ponds. The density of sinks in this region rivals that observed in the quarry north of Gypsumville. In many respects the two groups are similar, with both phreatic tubes and vadose passageways being represented. Several of the 50 to 60 cm high, flat-roofed cylindrical crawlways display widespread lenses and cross-cutting veinlets of satin spar, as well as preferentially eroded coarse grained gypsum and selenite. The largest of the mazes (**Catacomb-Satin Spar**) links several of the entrances, which are typically tight horizontal squeezes exposed at the base of massive gypsum beds forming the walls of the sinkholes. The **Catacomb** system contains several offshoot passageways that have not yet been fully explored; return visits during the summer of 1990 were thwarted by winter ice and pools of standing water.

To the north, **Sugar Shaft** exhibits smooth concave solution-grooved passageways and chambers in a relatively massive, coarse grained and thickly bedded unit of white saccharoidal gypsum, quite dissimilar to the thinly layered and commonly shaley beds observed in the walls of **Catacomb**, a short distance to the south. This extreme lateral variation in the nature of the bedrock was also confirmed during the industrial minerals drilling program conducted during the latter part of 1990 (see Report GS-30, this volume).

Traverses further to the west located the ridge historically referred to as "Anhydrite Hill" together with the northeast- trending ravine containing beds of blue anhydrite, originally worked by Messrs. Fry and Dulman in 1913 (Parks, 1916, p. 271,272). One small blind cave entrance was noted at the northern end of this ridge that is prominently cratered by several overlapping and beaded 3 to 5 m deep dolines.

South of the Warpath Trail a small area of polygonal karst was encountered in the northeast corner of Section 34, Twp. 32, Range 8W (Fig. GS-29-1). Two small blind cave entrances were encountered in gypsum outcrops at the edge of a nearby beaver pond; one shows signs of axe or claw marks around the entrance.

Several attempts were made to extend the mapping during 1990, but deep snowfall during the winter, ice blockages during the spring, and standing water and local ice during the summer handicapped the process well into September, some passageways in **Labyrinth** and **Crystal Palace** were totally impassible. Further efforts will continue into October, with results being published at a later date.

## DRILLING PROGRAM

Three holes were drilled south of Gypsum Lake to provide additional information regarding the thickness and extent of gypsum deposits in this region, and to investigate the possibility of other potentially economic deposits in the evaporite sequence. A full report on the drilling program is provided by Bezys and Gunter (Reports GS-30 and GS-31, this volume), together with drill logs for these holes, and others in the Gypsumville region.

The drilling program yielded good sections of gypsum, lying directly above thick shaley red beds with minor anhydrite nodules, and underlying "meltrock" and highly kaolinized granite breccias. This sequence is similar in most respects to sections encountered in previous drilling to the west (McCabe, 1983), and appears typical for the Gypsumville structure. Extreme variations were noted in the thickness of gypsum encountered, most noticeably in hole M-14-90 where only 50 cm of gypsum was found in an area flanked, on both sides, by sinkholes containing exposed massive gypsum beds 2 to 3 m thick. Extreme, locally focussed solutioning, or local small scale faulting might account for the inconsistencies and lateral variations in the lithologies, observed between drill holes and between adjacent caves. No new evaporite minerals were encountered. Several additional holes are planned for the northern sector during 1991.

## ACKNOWLEDGEMENTS

None of this work would have been possible without the continued and enthusiastic assistance of Hugo Copper, David Wright, Peter Voitovici, Dale Brown, Jane Rawluk and other members of the SSM. All of the above noted individuals have played a key role in undertaking the exploration of the Gypsumville region and in mapping the caves. Much still remains to be done in this and other sectors of the Interlake, to uncover the karst heritage of the province that has so far been overlooked. The Departments of Natural Resources and Energy and Mines have jointly recognized the importance of these features in the Interlake region, and have accordingly entered into discussions that will lead to more cooperative work between these agencies.

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# CAVES OF THE GYPSUMVILLE, GYPSUM LAKE AND SOUT

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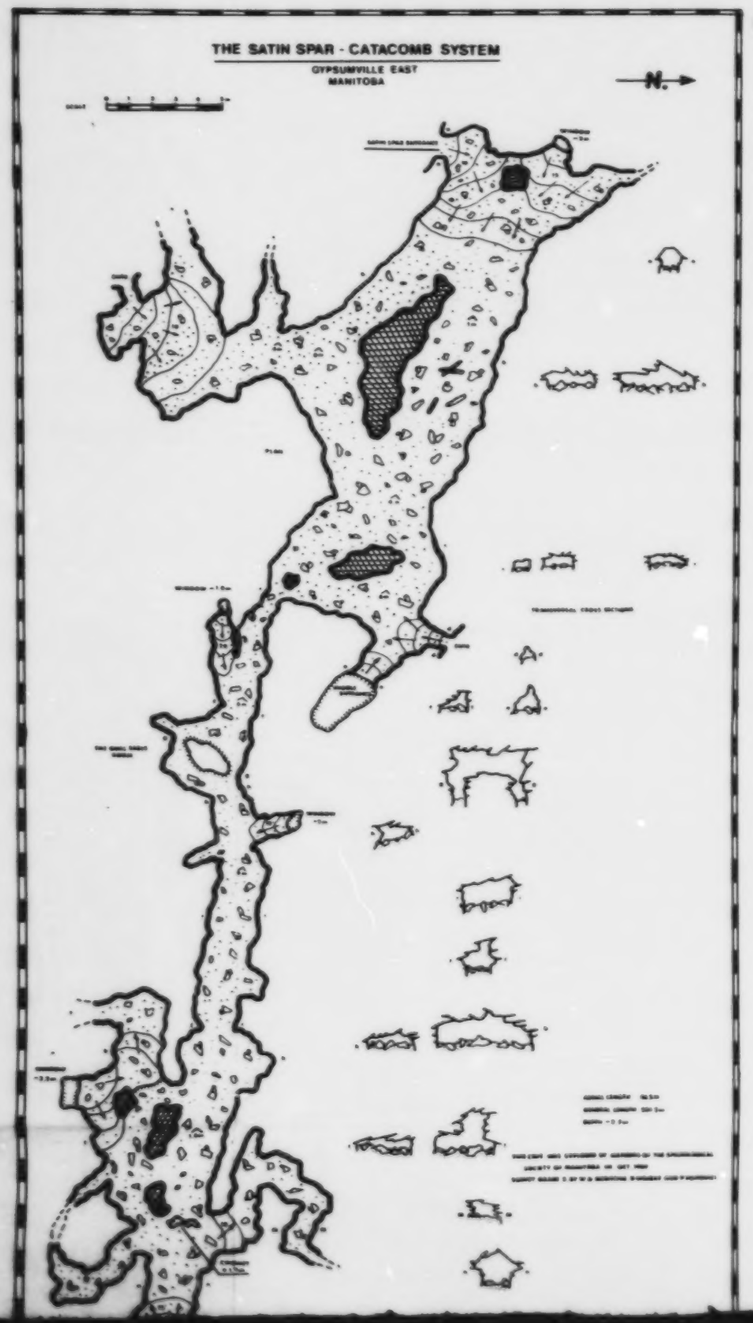


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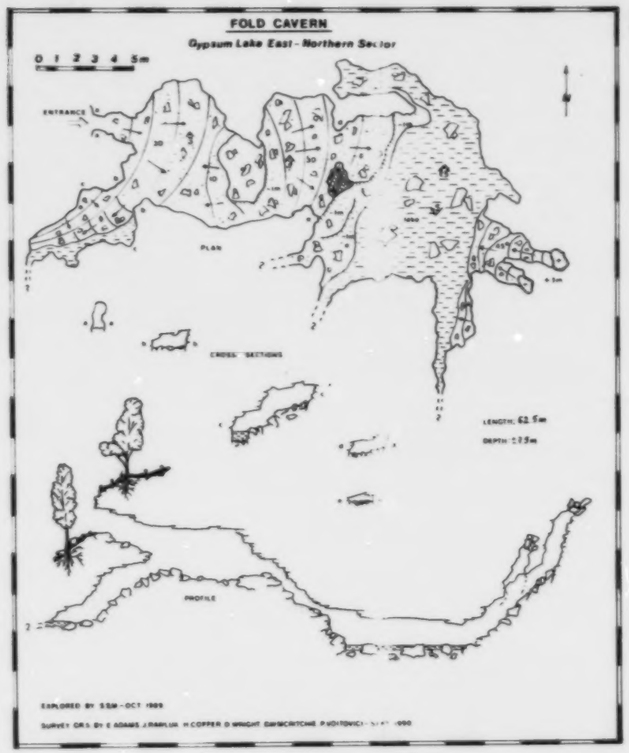


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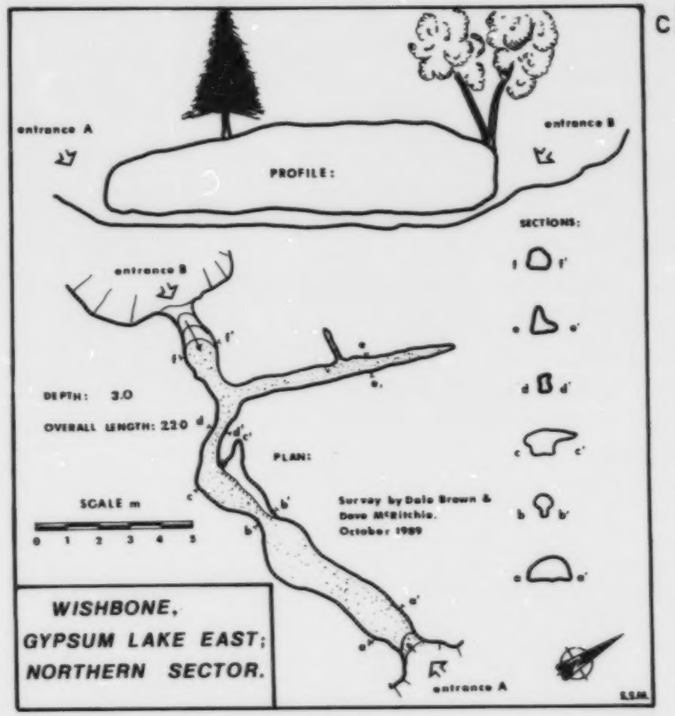


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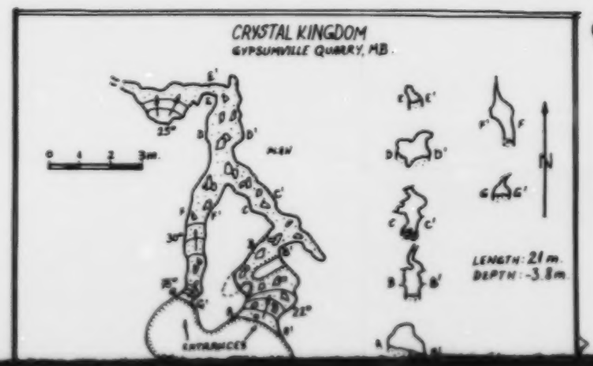


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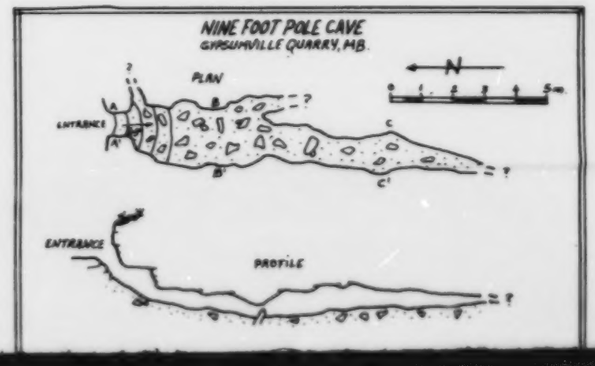

# LAKE AND SOUTHERN INTERLAKE REGION, MANITOBA

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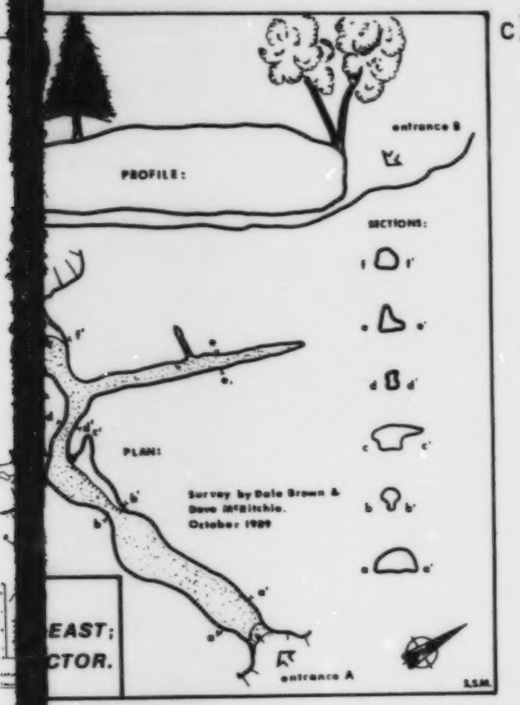


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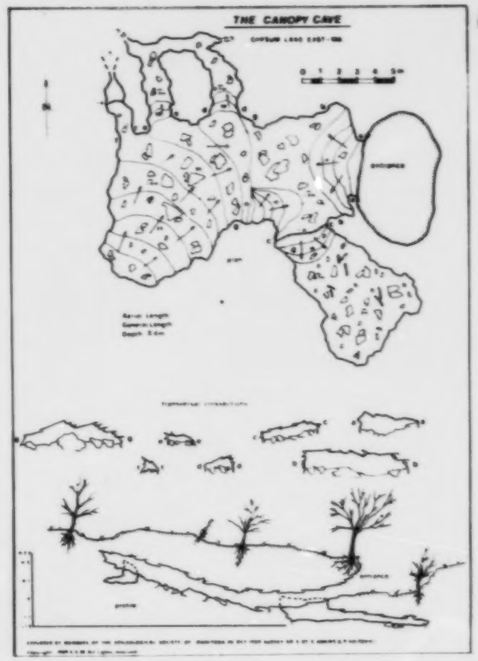


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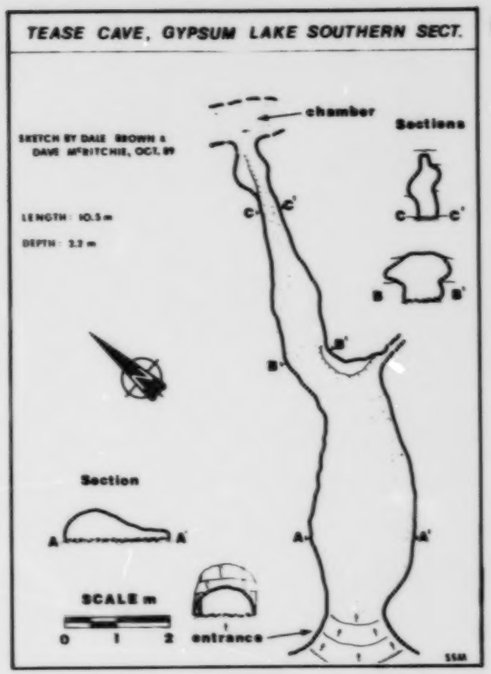


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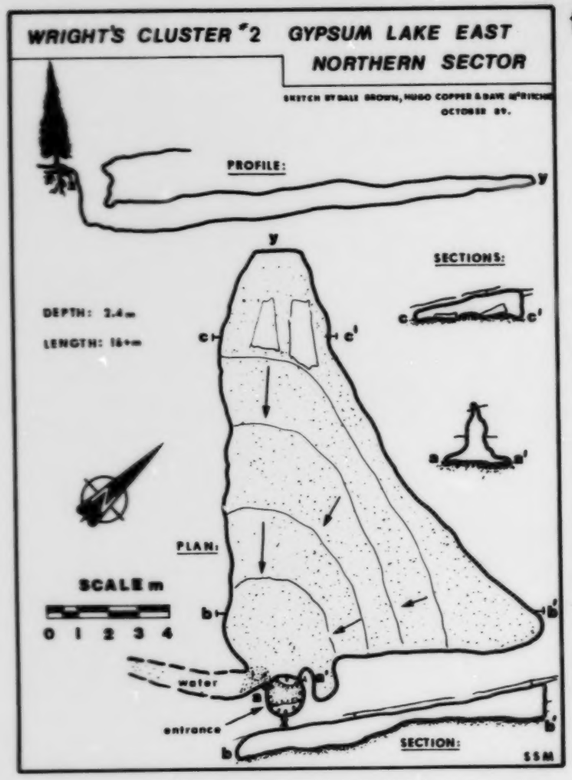


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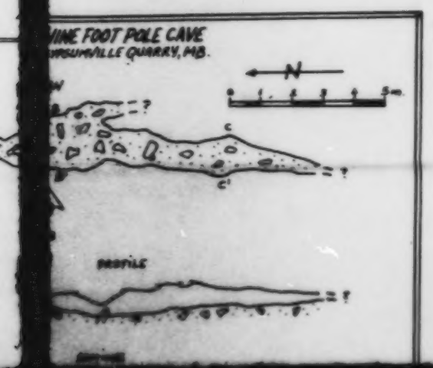


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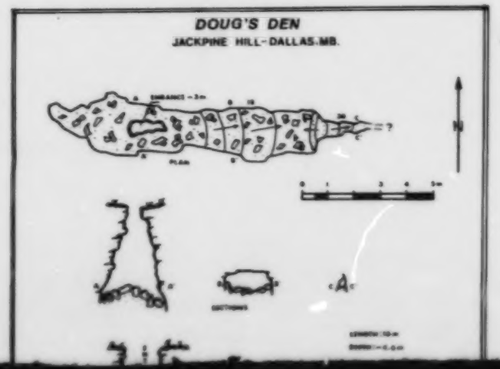


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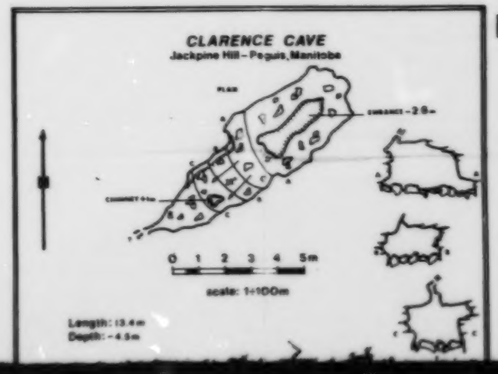


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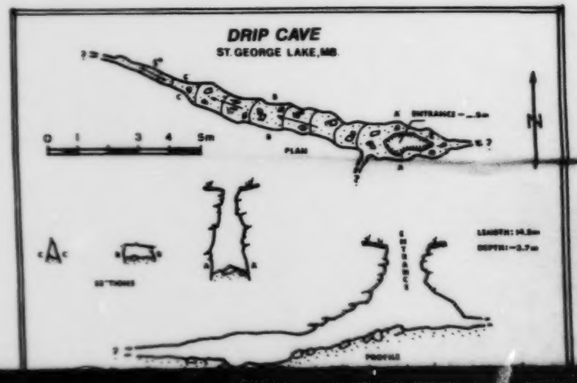

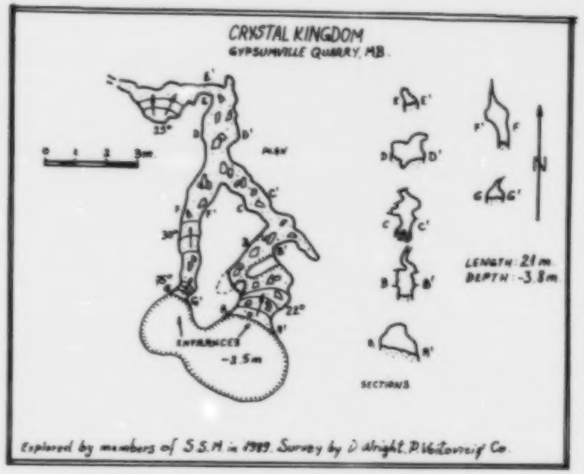


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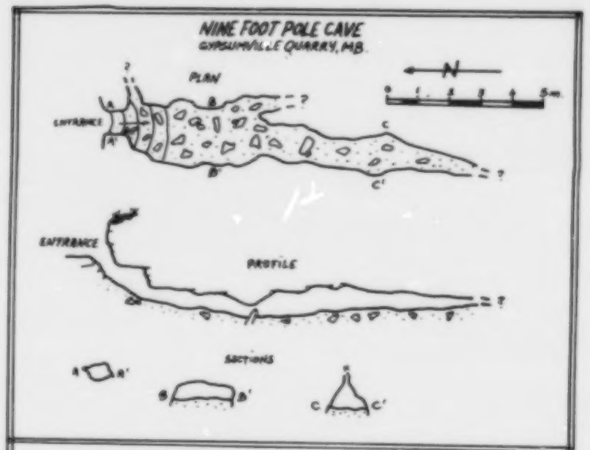


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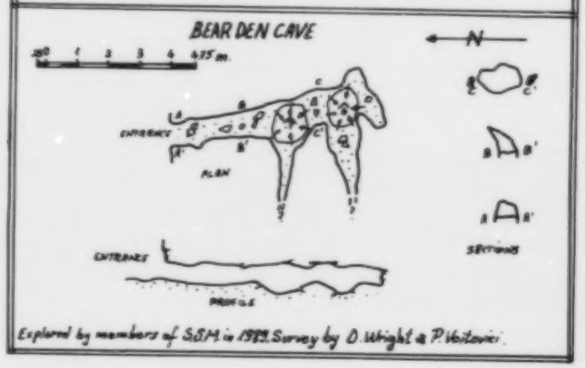


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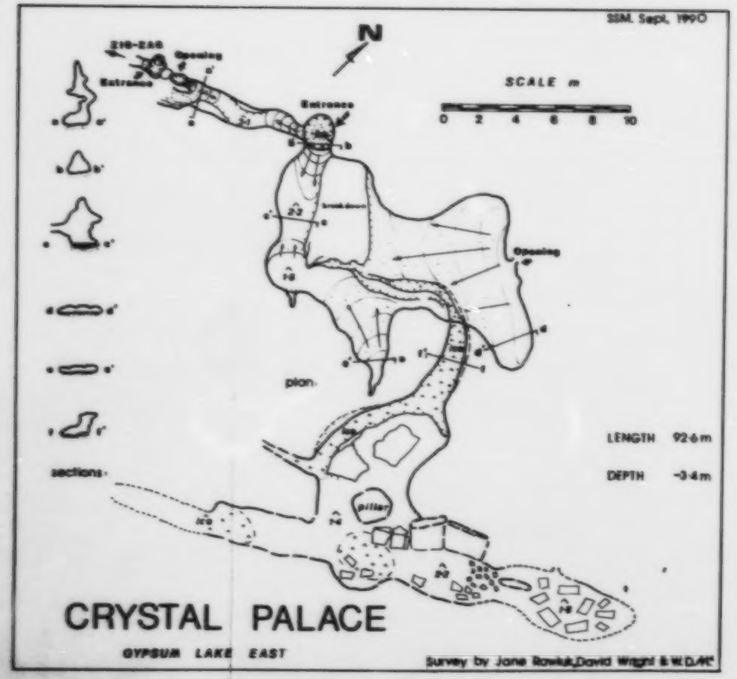


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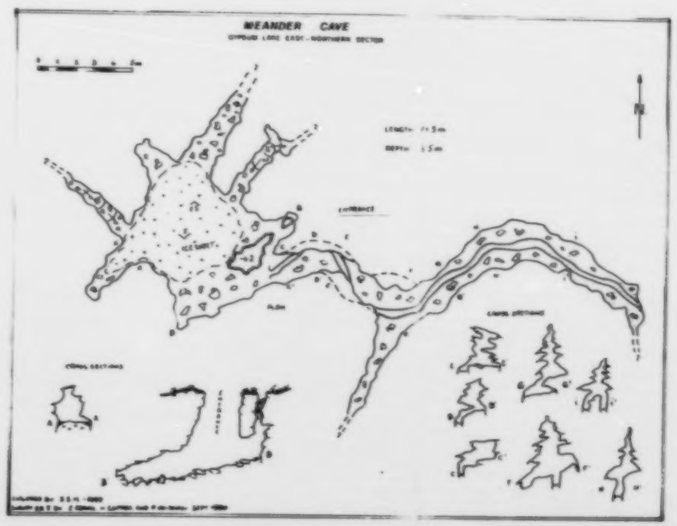
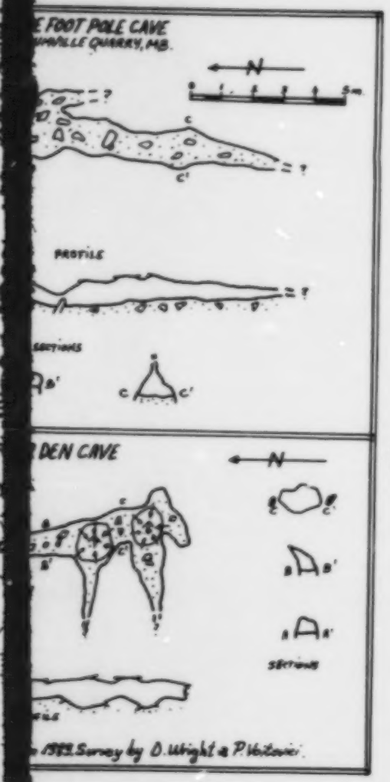



o)

Figure GS-29-14: a) Satin Spar-Co
e) Tease Cave; f) Wright's Cluster
j) Doug's Den; k) Clarence Cave; l)

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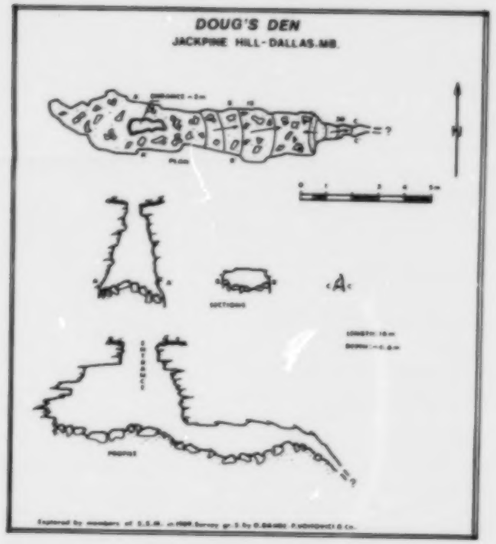


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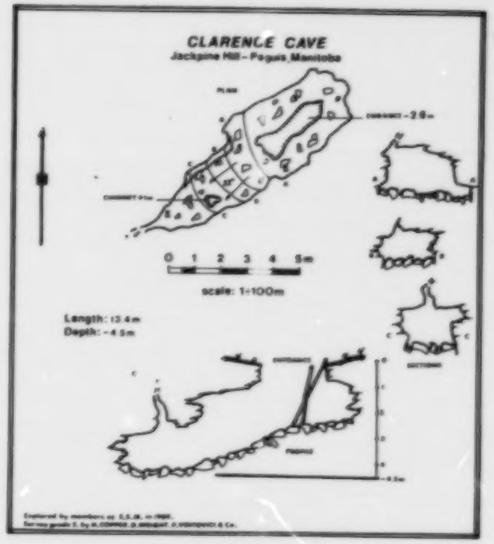


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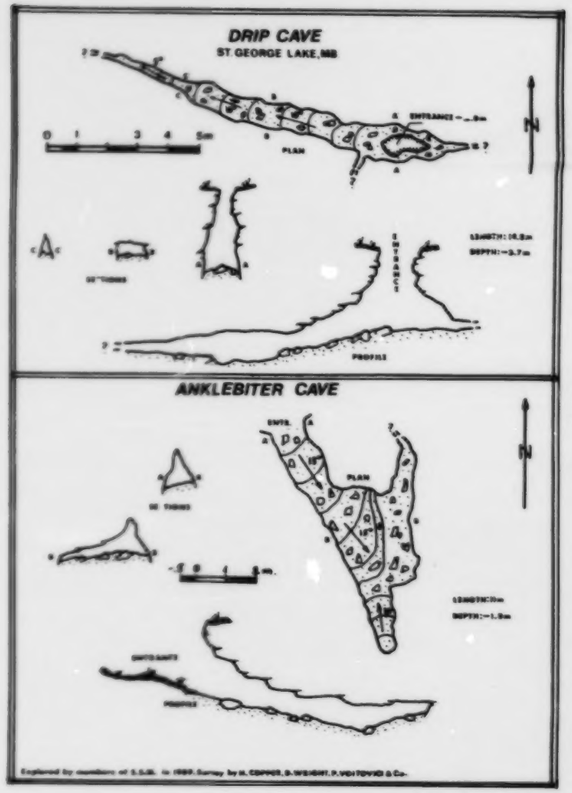


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Figure GS-29-14: a) Satin Spar-Catacomb System; b) Fold Cavern; c) Wishbone; d) The Canopy Cave; e) Tease Cave; f) Wright's Cluster #2; g) Crystal Kingdom; h) Nine-foot pole Cave; i) Bear Den Cave; j) Doug's Den; k) Clarence Cave; l) Drip Cave; m) Anklebiter Cave; n) Crystal Palace; o) Meander Cave.